



**Fermi National Accelerator Laboratory
Batavia, IL 60510**

FERMI MAIN INJECTOR

3Q60 OUTER COIL WINDING TRAVELER

Reference Drawing(s)

**3Q60 Outer Coil Layout ME-331982
3Q120 And 3Q60 Coil Winding Layout
ME-115399/ME-351007
3Q60 Half-Coil Assembly MD-331984**

Budget Code: MYI Project Code: CCW

Released by: Date:

Prepared by: W. L. Isiminger

Title	Signature	Date
TD / E&F Process Engineering	Bob Jensen	6/19/98
TD / E&F Assembly	James Clark	6-19-98
TD / E&F Tooling	Claron	6/19/98
TD / E&F Fabrication Manager	Claron	6/19/98
TD / E&F Device Design	Claron	6/19/98
TD / E&F Department Head	Claron	6/19/98
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TD / Main Injector Magnet Project Manager	Duff Hardy	6/23/98
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Revision Page

Revision	Revision Description	Date
A	Step 7.1: Changed electrical resistance specification from 6.5 m Ω - 7.2 m Ω to 3.3 m Ω - 3.7 m Ω . Step 7.3: Changed flow rate specification from 0.75 GPM @ 60 psi and 1.0 GPM @ 100 psi to 1.00 GPM @ 60 psi and 1.35 GPM @ 100 psi. TRR. No. 0846	06/03/98
B	Step 4.20: Deleted the not required box and statement. Step 6.5: Changed 6.24 to 6.26. Step 6.21: Deleted the not required box and statement. Step 7.1: Added Ls and Q limits for 100 Hz measurements per unreleased specification ES-331810 Rev. D received from D. Gaw. Step 7.3: Changed flow specifications from 1.0 GPM to 1.10 GPM and 1.35 GPM to 1.45 GPM, per unreleased specification ES-331810 Rev. D received from D. Gaw. TRR. No. 0849	06/18/98

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 General Notes

- 1.1 White (Lint Free) Gloves (Fermi stock 2250-1800) or Surgical Latex Gloves (Fermi stock 2250-2494) shall be worn by all personnel when handling all product parts after the parts have been prepared/cleaned.
- 1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.
- 1.3 No erasures or white out will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.
- 1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.
- 1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.
- 1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.
- 1.7 Cover the 3Q60 Coil Assembly with green Herculite (Fermi stock 1740-0100) when not being serviced or assembled. Completed coils are to be stored in the 3Q60 Coil Storage Area.

2.0 Parts Kit List

- 2.1 Attach the completed Parts Kit List for the 3Q60 Coil Winding to this traveler. Ensure that the serial number on the Parts Kit List matches the serial number of this traveler. Verify that the Parts Kit received is complete.

Process Engineering/Designee

Date

3.0 Coil Winding Table Setup Procedure for the Outer Coil**Note(s):****Ensure that only trained/approved operators use the equipment.**

- 3.1 Set up the Winding Fixture (ME-351007) for the 3Q60 Outer Coil as shown on ME-351007, (Winding Setup for 3Q60 Coils). All coil contacting surfaces of the fixture must be cleaned with KPC 820N (Fermi stock 1920-0705) and Heavy Disposable Wipers (Fermi stock 1660-2600) or equivalent

Technician(s)_____
Date

- X 3.2 Using a Steel Measuring Tape (Starrett Cat. No. W530F-50 or equivalent) verify the length of the winding mandrel from the outer most side of the Front End Winding Block (MC-331926) - lead end to the outside of the Rear End Winding Block (MB-198791) - return end. The nominal length is to be (62 3/16" to 62 7/32").

Record Actual Dimension _____

Lead Person_____
Date

- X 3.3 Perform a BB Inspection of the grit blasted conductor cooling passage with a .219" diameter ball bearing. Cover the exit hole on the reel of conductor with a rag or slide a glove over the end of the conductor to catch the ball bearings. Use minimum required air pressure (< 10 psi.). Test two (2) reels of Conductor (MA-186587).

Reel # 1 Pass ☒ Fail ☐Reel # 2 Pass ☐ Fail ☐**Note(s):****If the BB Inspection fails notify supervisor.**_____
Lead Person_____
Date

- 3.4 Install the coil starting lead into the Setco Counter Boring and Facing Fixture center the coil lead in the fixture, so there is 1/32" \pm 1/64" past the plate. Tighten the De-StaClamp to secure the coil starting lead into place.

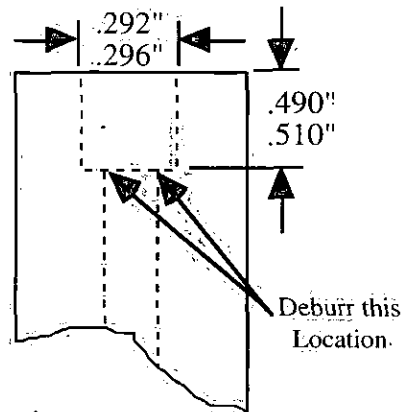
Note(s):**Take care not to damage the conductor during the installation into the Counter Boring and Facing Fixture.****The drill bit must align with the center of the conductor not the center of the water passage.**_____
Technician(s)_____
Date

- 3.5 Machine and counter bore the coil starting lead as per ME-331982. Using a Tapered Ream (Fermi stock 1264-0800) or equivalent, deburr the water passage.

Note(s):

Use Snoop (Fermi stock 1070-2200 or equivalent) as required while machining the coil lead.

Do not remove any additional material from the face of the coil lead.



Deburr all sharp edges produced by the previous operations. Clean the conductor, water passages and the immediate area using a vacuum. Remove any additional milling chips from the water passages by holding the vacuum hose over one of the water passages and blowing air through the other water passage, switch the hoses and repeat until the water passage is free of debris.

Technician(s)

Date:

- X. 3.6 Verify the counter bore diameter and depth of the conductor using the Go/No Go Gage (MA-351136) or approved measuring equipment and that the conductor leads comply with ME-331982. Record the results in the table below.

Counter Bore Inspection						
Location	Limit	Pass	Fail	Limit	Pass	Fail
Starting Lead	.292"/.296"			.490"/.510"		

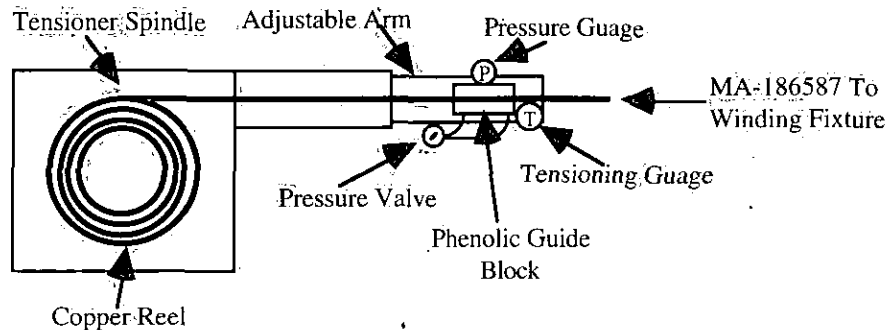
Lead Inspector

Date

Definition:

A Completed Turn is when the tensioned lead is parallel with the clamped starting lead. Hence one completed turn consists of two (2) 180° radii.

- 3.7 Set the adjustable tensioning arm on the spindle to the half way point. Install a reel of copper conductor (4096" sq. MA-186587) on the tensioner spindle and feed the conductor through the Phenolic guide block.

**Note(s):**

Use the proper lifting equipment to prevent back injury during the installation of the reel on the tensioner spindle.
Ensure that no twist has occurred in the conductor between the reel and the Phenolic guide block.

 Technician(s)

 Date

- 3.8 Starting approximately 18.00" \pm 1/32" from the end of the conductor which was just fed through the Phenolic guide block, wrap the conductor using the (Coil Insulating Wrapper II ME-351226 or other pre-approved methods) with 1/2 lapped Fiberglass Tape (MA-351462). This process is to be continued during the entire winding operation.

Note(s):

During the wrapping process the tape must be 1/2 lapped to within \pm 1/8".
Transitions between the Fiberglass Tape (MA-351462) and the Fiber Glass Tape (MA-351462) must be made so that no area of the conductor is uninsulated and additional build-up of the tape is minimized.

 Technician(s)

 Date

Note(s):

No insulation is to be placed at the transition. This area will be insulated at a later time manually.

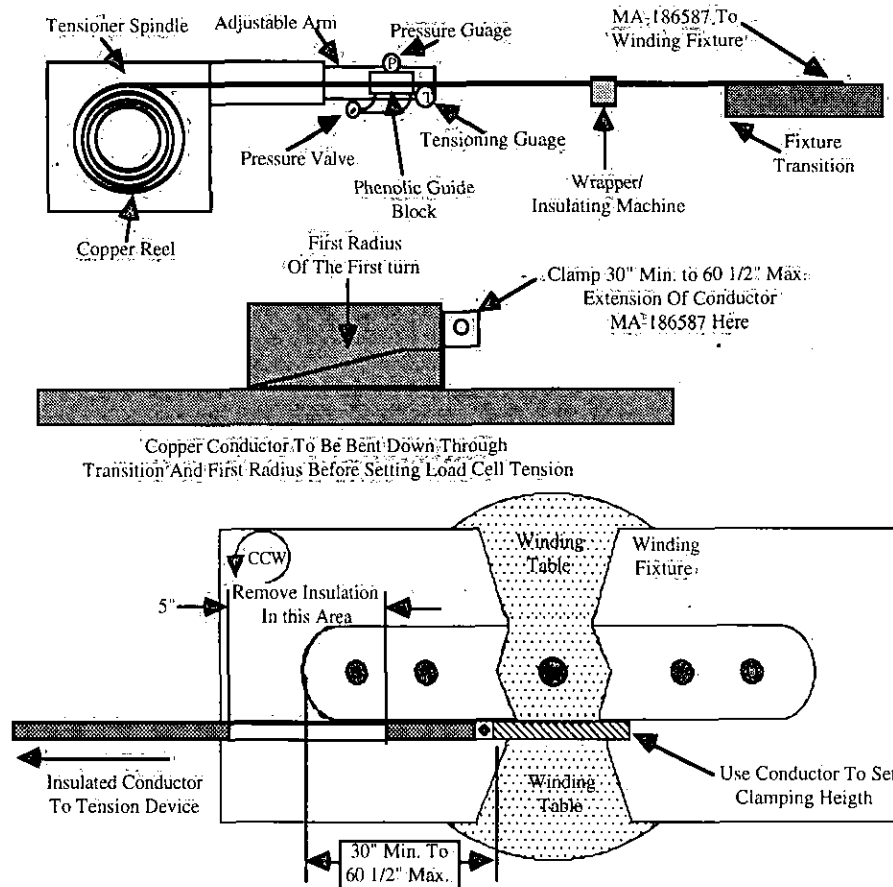
At no time is a hammer to be used directly against the insulated conductor.

- 3.9 Extend the end of the insulated conductor approximately 30" minimum to 60 1/2" maximum onto the winding table and clamp the end of the insulated conductor at a height sufficient enough for the insulated conductor to pass below the clamped conductor. Engage the winding table in the **Counter-Clockwise** direction winding down the transition to the fixture Cover Plate (MB-351013) clamping the conductor as required.

Adjust the pressure valve to pressurize the tensioner clamping cylinder as you wind down the transition through the first radius of the first turn, ensuring that the maximum pressure does not exceed 250 Lbs force. Begin winding table rotation until the tensioner load cell gauge registers winding tension. Adjust the clamping cylinder pressure so that the load cell gauge reads 225 Lbs. force ± 25 Lbs. Maximum pressure should not exceed 250 Lbs force.

Caution:

At no time during the winding process is the conductor wrap to become damaged or is there to be exposed copper present other than that located at the transition. Constant monitoring during the winding process is required to ensure these conditions do not occur.



Technician(s) _____

Date _____

- X 3.10 Verify that the tension of the conductor load cell gauge reads 225 Lbs. force \pm 25 Lbs measured during the continued winding table rotation. Ensure that the maximum readings do not exceed 250 Lbs. force. Visually verify that there is no exposed copper or damaged conductor wrap.

Record Actual Tension _____

Pass

☐

Fail

☐

Conductor Wrap Is Free Of Damage And There Is No Exposed Copper

Pass

☐

Fail

☐_____
Lead Person_____
Date

4.0 Coil Winding (Bottom Layer)**Note(s):**

For all subsequent operations of the winding table refer to the Large Turn Table (Winding Table) Operation Procedure (5525-OP-318944).

At no time is a hammer to be used directly against the insulated conductor.

If splicing is required refer to ME-331982 under Notes.

- 4.1 Engage the winding table, continue insulating the conductor and use minimum hammer force necessary to form the turns and avoid conductor/insulation damage. Monitor the tension at all times so as not to exceed 250 Lbs. Continue winding through the first radius of the first turn until the insulated conductor contacts the long straight section of the winding fixture and stop. Clamp the conductor to the winding fixture using c-clamps.

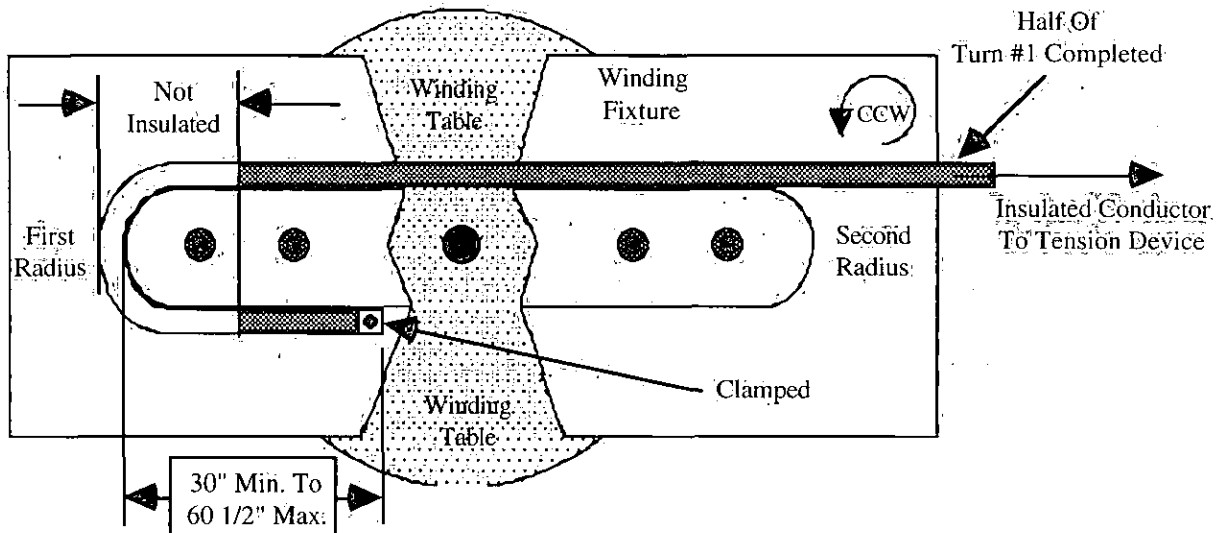
Warning:

Continual visual inspection of the conductor is required during the winding process for voids in the insulation and or possible damage to the insulated conductor.

Note(s):

Fixture rotation should be counter clockwise.

The square conductor must be under constant tension of 225 Lbs. \pm 25 Lbs. and must not be allowed to twist during winding:



Technician(s)

Date

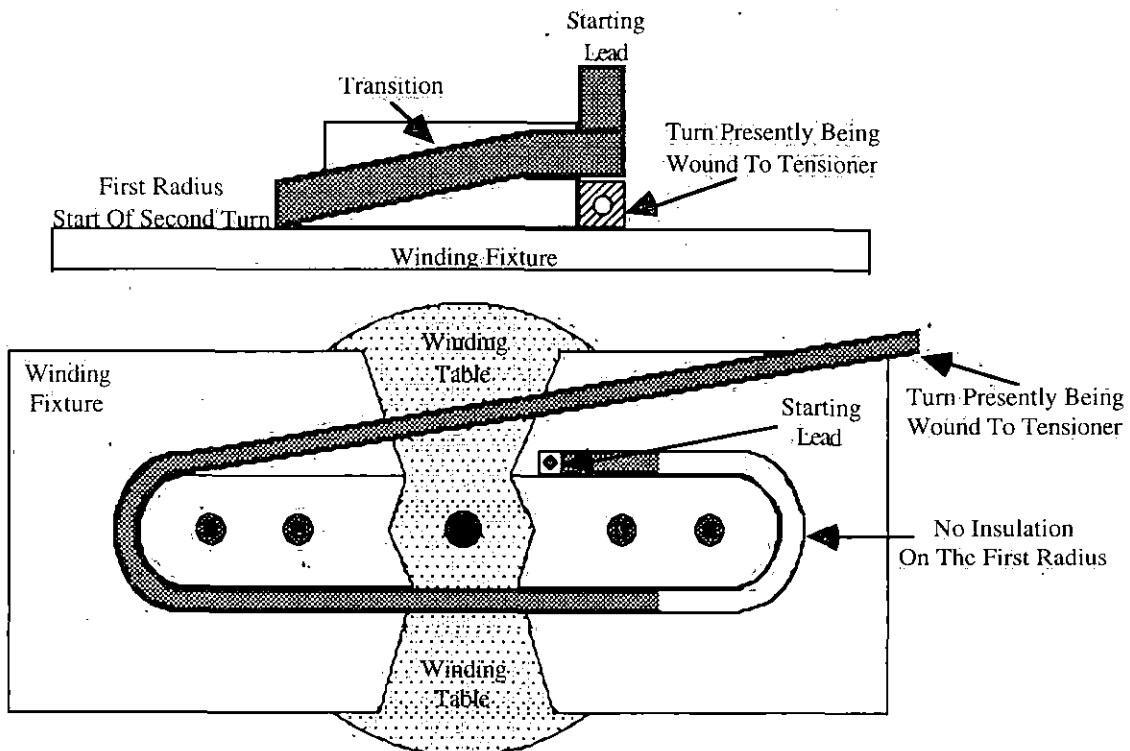
- X 4.2 Perform a Height and Width Dimension Check of the uninsulated conductor half-way between the tensioner and the winding fixture.

Dimension	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Height	(.4056") to (.4136")				
Width	(.4056") to (.4136")				

Lead Person _____

Date _____

- 4.3 Wind half way through the second radius of the first turn, clamping the conductor to the winding fixture using c-clamps and stopping prior to the clamped starter lead. Very slowly slide the conductor under the starting lead as winding through the second radius continues, ensuring that the turn being wound has no damage to the insulation. Once the conductor is parallel to the winding fixture, this completes one (1) full turn of the coil.

**Note(s):**

When additional Fiberglass Tape (MA-351462) needs to be attached to the machine and conductor it should be interwoven by hand at the conductor and .007" X 1/2" Adhesive Backed Fiberglass Tape (MA-225104) used to attach the tapes or other approved methods that keep tape buildup to a minimum.

Technician(s) _____

Date _____

Note(s):

After completion of the first turn position DMD (MA-116514) between each turn at the radii.

- 4.4 Continue insulating and winding the coil in this manner until all three (3) turns of the first layer have been wound with the lead exiting the same side as the starter lead, or until such time as additional conductor is required.

Warning:

Continuous monitoring of the conductor at the tensioner is required so as not to pull the conductor free of the tensioner. Ensure that during the winding process no twisting of the conductor occurs.

Note(s):

In the event additional conductor is required, allow at least four (4) feet of bare conductor to work with for facing and brazing operations.

Additional Conductor Required. Go to Step 4.5 ☐

Winding completed. Go to Step 4.25. ☐

Technician(s)

Date

- 4.5 Stop the winding/insulating process at the nearest radius that allows the conductor to remain in the tensioning device. Securely clamp the conductor to the winding fixture. Release the tensioner. Cut the lead as close to the tensioner as possible for machining, yet the cut and machined length must fall greater than six (6") inches from the nearest radius.

Note(s):

Do not insulate the conductor to the cut location. Leave four (4) feet uninsulated. Cutting the roll of Fiberglass tape and removal of the machine or leaving the machine and Fiberglass tape attach to the conductor is at the operator's discretion.

Technician(s)

Date

- 4.6 Install the coil starting lead into the Setco Counter Boring and Facing Fixture center the coil lead in the fixture, so there is $1/32" \pm 1/64"$ past the $5/16"$ Collet (5C Collar). Tighten the De-StaClamp to secure the coil starting lead into place.

Note(s):

Take care not to damage the conductor during the installation into the Counter Boring and Facing Fixture.

The drill bit must align with the center of the conductor not the center of the water passage.

Technician(s)

Date

Note(s):

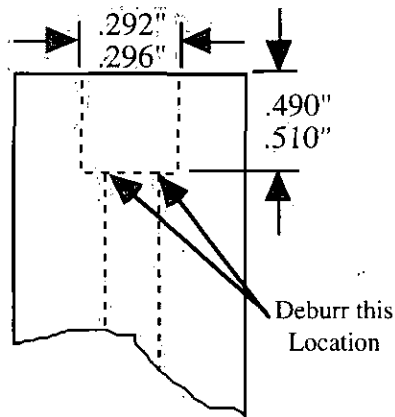
In the event no additional conductor is required step 4.5 through 4.24 will be blank.

- 4.7 Machine and counter bore the coil starting lead as per ME-331982. Using a Tapered Ream (Fermi stock 1264-0800) or equivalent, deburr the water passage.

Note(s):

Use Snoop (Fermi stock 1070-2200 or equivalent) as required while machining the coil lead.

Do not remove any additional material from the face of the coil lead.



Deburr all sharp edges produced by the previous operations. Clean the conductor, water passages and the immediate area using a vacuum. Remove any additional milling chips from the water passages by holding the vacuum hose over one of the water passages and blowing air through the other water passage, switch the hoses and repeat until the water passage is free of debris.

Technician(s)

Date

- X 4.8 Verify the counter bore diameter and depth of the conductor using the Go/No Go Gage (MA-351136) or approved measuring equipment and that the conductor leads comply with ME-331982. Record the results in the table below.

Counter Bore Inspection						
Location	Limit	Pass	Fail	Limit	Pass	Fail
Coil Lead	.292"/.296"			.490"/.510"		

Lead Inspector

Date

Note(s):

In the event no additional conductor is required step 4.5 through 4.24 will be blank.

- 4.9 Install a reel of grit blasted copper conductor (.4096" sq. MA-186587) on the tensioner spindle. Feed the conductor through the Phenolic guide block. Extend the conductor to the counter bore/facing machine.

Note(s):

Use the proper lifting equipment to prevent back injury during the installation of the reel on the tensioner spindle.

Ensure that no twist has occurred in the conductor between the reel and the Phenolic guide block.

Technician(s)

Date

- 4.10 Install the reel lead into the Setco Counter Boring and Facing Fixture center the coil lead in the fixture, so there is $1/32" \pm 1/64"$ past the $5/16"$ Collet (5C Collar). Tighten the De-StaClamp to secure the coil starting lead into place.

Note(s):

Take care not to damage the conductor during the installation into the Counter Boring and Facing Fixture.

The drill bit must align with the center of the conductor not the center of the water passage.

Technician(s)

Date

Note(s):

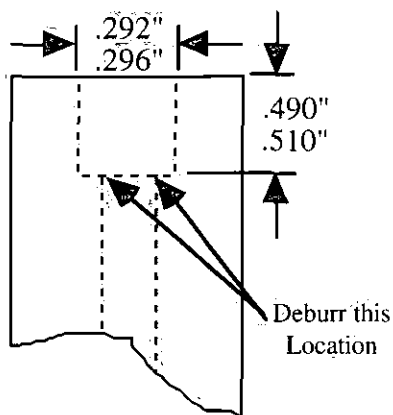
In the event no additional conductor is required step 4.5 through 4.24 will be blank.

- 4.11 Machine and counter bore the reel lead as per ME-331982. Using a Tapered Ream (Fermi stock 1264-0800) or equivalent, deburr the water passage.

Note(s):

Use Snoop (Fermi stock 1070-2200 or equivalent) as required while machining the coil lead.

Do not remove any additional material from the face of the coil lead.



Deburr all sharp edges produced by the previous operations. Clean the conductor, water passages and the immediate area using a vacuum. Remove any additional milling chips from the water passages by holding the vacuum hose over one of the water passages and blowing air through the other water passage, switch the hoses and repeat until the water passage is free of debris.

Technician(s)

Date

- X 4.12 Verify the counter bore diameter and depth of the conductor using the Go/No Go Gage (MA-351136) or approved measuring equipment and that the conductor leads comply with ME-331982. Record the results in the table below.

Counter Bore Inspection						
Location	Limit	Pass	Fail	Limit	Pass	Fail
Reel Lead	.292"/.296"			.490"/.510"		

Lead Inspector

Date

- X 4.13 Assemble the Copper Sleeve (MA-186691), with the Sil-Fos #15 Washers (MA-351037), and the two (2) Sil-Fos #15 Rings (MA-186692) per print ME-331982.

Lead Person

Date

Note(s):

In the event no additional conductor is required step 4.5 through 4.24 will be blank.

- 4.14 Position the coil lead and the lead from the reel such that the two may be joined together. Assemble the sleeve into the lead of the coil and the lead of the reel.

 Technician(s)

 Date

- 4.15 Attach the brazing fixture (MB-351443) to the conductors about to be joined together. Align the conductors such that there is no twist between the two leads.

 Technician(s)

 Date

X

- 4.16 Verify the position of the components to be brazed together as per ME-331982.

 Lead Person

 Date

- 4.17 Heat the leads with a torch until the area surrounding the joint is cherry red. Apply Sil-Fos # 15 (MA-116256) at the joint. Feed the Sil-Fos #15 into the joint and move the torch around the joint to produce 100% Sil-Fos #15 flow and a uniform braze. Refer to the General Brazing Specification (ES-318973).

Note(s):

CAUTION, material and areas being heated represent a burn hazard.

Do not over heat the material causing the copper to flow.

Do not use water to cool the joints. Allow all brazed joints to air cool.

 Technician(s)

 Date

- 4.18 Remove the conductor from the brazing fixture and cover the insulated coil/conductor with green Herculite (Fermi stock 1740-0100). Using Brown Roloc (MA-274983) and a small buffer, remove any excess brazing material. Remove only material where the conductor exceeds the .4136" slot (maximum) of the Dekeystoning Gage (MB-351442). Refer to the Conductor Dekeystoning Procedure (5520-ES-318849).

Note(s):

Remove only the minimum amount of material necessary. At no time is the removal of material to produce an area in which the minimum gage .4056" (MB-351442) fits over the conductor.

 Technician(s)

 Date

Note(s):

In the event no additional conductor is required step 4.5 through 4.24 will be blank.

- XX** 4.19 Verify that the position of the brazed components are in accordance with ME-331982 and that there is no twists or damage in the conductor or brazed joint. Using the Dekeystoning Gage (MB-351442) ensure that the conductor is of the correct size at the brazed joint.

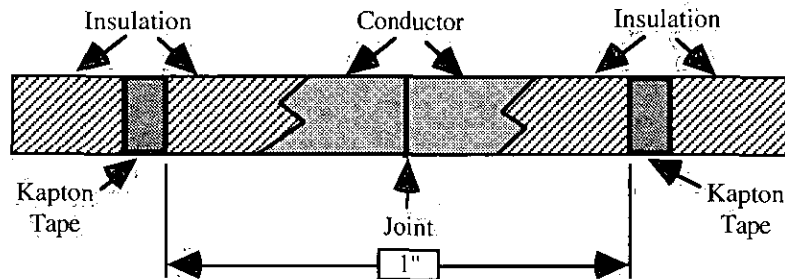
Crew Chief

Date

Inspector

Date

- 4.20 Reattach the Fiberglass Tape (MA-351462) using the (Coil Insulating Wrapper II ME-351226 or other pre-approved methods) with 1/2 lapped Fiberglass Tape (MA-351462) if required. Prior to starting the winding operation, insulate over the braze joint and mark its location using Kapton Adhesive Backed Tape (MA-116534 or equivalent) as indicated in the diagram below. The insulation process is to be continued during the entire winding operation.

**Note(s):**

Transitions between the Fiberglass Tape (MA-351462) and the Fiber Glass Tape (MA-351462) must be made so that no area of the conductor is uninsulated and additional build-up of the tape is minimized.

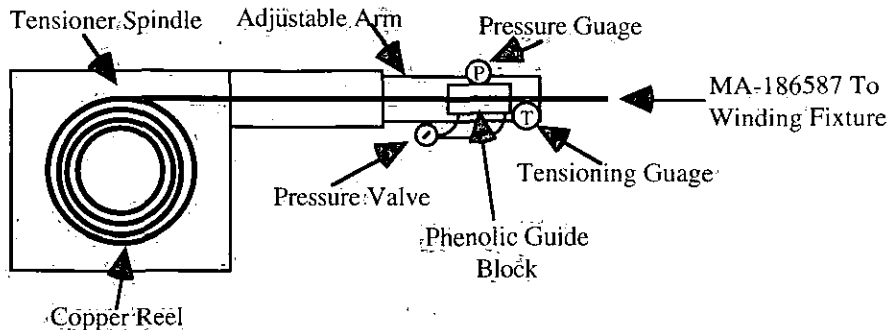
Technician(s)

Date

Note(s):

In the event no additional conductor is required step 4.5 through 4.24 will be blank.

- 4.21 Set the adjustable tensioning arm on the spindle to the half way point and feed the conductor through the Phenolic guide block.

**Note(s):**

Use the proper lifting equipment to prevent back injury during the installation of the reel on the tensioner spindle.
Ensure that no twist has occurred in the conductor between the reel and the Phenolic guide block.

Technician(s)

Date

- 4.22 Begin winding table rotation (**Counter Clockwise**) until the tensioner load cell gauge registers winding tension. Adjust the clamping cylinder pressure so that the load cell gauge reads 225 Lbs. force ± 25 Lbs. Maximum pressure should not exceed 250 Lbs. force.

Technician(s)

Date

- X 4.23 Verify that the tension of the conductor load cell gauge reads 225 Lbs. force ± 25 Lbs. measured during the continued winding table rotation. Ensure that the maximum readings do not exceed 250 Lbs. force. Visually verify that there is no exposed copper or damaged conductor wrap.

Record Actual Tension _____

Pass ☐ Fail ☐

Conductor Wrap Is Free Of Damage And There Is No Exposed Copper

Pass ☐ Fail ☐

Lead Person

Date

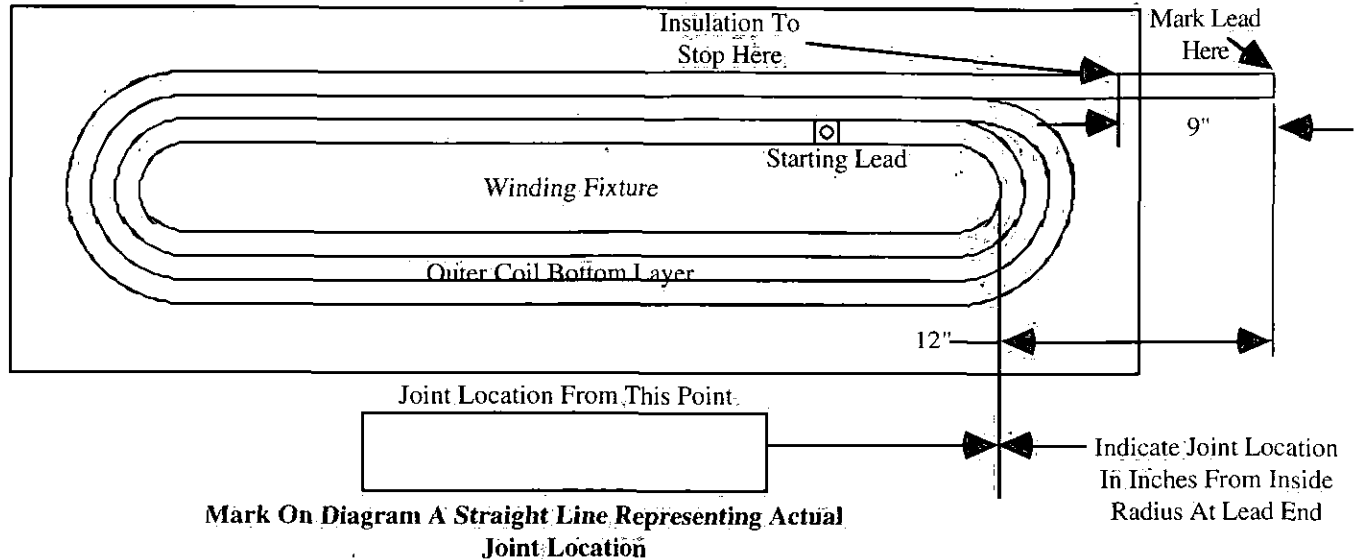
- 4.24 Continue insulating and winding the coil in this manner until all three (3) turns of the first layer have been wound with the lead exiting the same side as the starter lead.

Technician(s)

Date

- 4.25 Clamp the conductor to the winding fixture. Measure $12" \pm 1/2"$ from the face of the Front End Winding Block (MC-331926) on the lead attached to the tensioning device, mark the lead to be cut. Secure the Fiberglass tape to the conductor 9" back from the 12" mark using Adhesive Backed Fiberglass Tape (MA-225104) or equivalent.

Caution: Do not cut lead.



In the diagram above, indicate the actual location of the joint just completed.

Technician(s)

Date

XX

- 4.26 Verify that all 3 turns are wound, that no twist is in the conductor, the lead is correctly measured and marked, that there is no damage to the insulation which is to include but not be limited to dirt, grease, oil, gaps/tears exposed conductor, etc... Visually verify that after completion of the first turn DMD (MA-116514) has been positioned between each turn at the radii.

Lead Inspector

Date

Crew Chief

Date

- 4.27 Cut the lead as marked using a portable band saw or equivalent at the 12" mark. Deburr all sharp edges produced by the cutting. Clean the conductor, water passages and the immediate area using a vacuum. Remove any additional milling chips from the water passages by holding the vacuum hose over one of the water passages and blowing air through the other water passage, switch the hoses and repeat until the water passage is free of debris.

Technician(s)

Date

5.0 Facing, Counter Boring and Brazing For Top Layer**Note(s):**

In the event a splice was introduced at the bottom layer, then the top layer must be completed without a splice. Hence a new reel of copper would be required for the completion of the top layer.

- 5.1 Install a reel of grit blasted copper conductor (.4096" sq. MA-186587) on the tensioner spindle. Feed the conductor through the Phenolic guide block. Extend the conductor to the counter bore/facing machine.

Note(s):

**Use the proper lifting equipment to prevent back injury during the installation of the reel on the tensioner spindle.
Ensure that no twist has occurred in the conductor between the reel and the Phenolic guide block.**

Technician(s)

Date

- 5.2 Install the reel lead into the Setco Counter Boring and Facing Fixture center the reel lead in the fixture, so there is $1/32" \pm 1/64"$ past the 5/16" Collet (SC Collar). Tighten the De-StaClamp to secure the coil starting lead into place.

Note(s):

Take care not to damage the conductor during the installation into the Counter Boring and Facing Fixture.

The drill bit must align with the center of the conductor not the center of the water passage.

Technician(s)

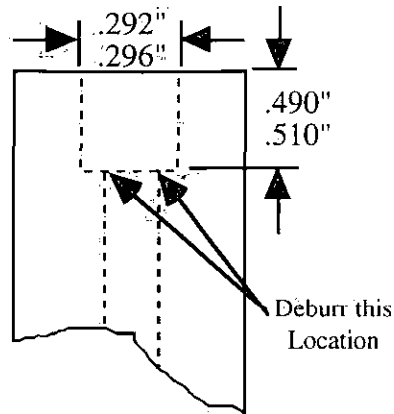
Date

- 5.3 Machine and counter bore the reel lead as per ME-331982. Using a Tapered Ream (Fermi stock 1264-0800), or equivalent, deburr the water passage.

Note(s):

Use Snoop (Fermi stock 1070-2200 or equivalent) as required while machining the coil lead.

Do not remove any additional material from the face of the coil lead.



Deburr all sharp edges produced by the previous operations. Clean the conductor, water passages and the immediate area using a vacuum. Remove any additional milling chips from the water passages by holding the vacuum hose over one of the water passages and blowing air through the other water passage, switch the hoses and repeat until the water passage is free of debris.

Technician(s)

Date

- X 5.4 Verify the counter bore diameter and depth of the conductor using the Go/No Go Gage (MA-351136) or approved measuring equipment and that the conductor leads comply with ME-331982. Record the results in the table below:

Counter Bore Inspection						
Location	Limit	Pass	Fail	Limit	Pass	Fail
Reel Lead	.292"/.296"			.490"/.510"		

Lead Inspector

Date

- X 5.5 Assemble the Copper Sleeve (MA-186691), with the Sil-Fos #15 Washers (MA-351037), and the two (2) Sil-Fos #15 Rings (MA-186692) per print ME-331982.

Lead Person

Date

- 5.6 Position the coil starter lead and the lead from the grit blasted reel such that the two may be joined together. Assemble the sleeve into the lead of the coil and the lead of the reel. Cover the 3Q60 Coil Assembly with green Herculite (Fermi stock 1740-0100).

Technician(s)

Date

- 5.7 Attach the brazing fixture (MB-351443) to the conductors about to be joined together. Align the conductors such that there is no twist between the two leads.

Technician(s)

Date

- X** 5.8 Verify the position of the components to be brazed together as per ME-331982.

Lead Person

Date

- 5.9 Heat the leads with a torch until the area surrounding the joint is cherry red. Apply Sil-Fos # 15 (MA-116256) at the joint. Feed the Sil-Fos #15 into the joint and move the torch around the joint to produce 100% Sil-Fos #15 flow and a uniform braze. Refer to the General Brazing Specification (ES-318973).

Note(s):

CAUTION, material and areas being heated represent a burn hazard.

Do not over heat the material causing the copper to flow.

Do not use water to cool the joints. Allow all brazed joints to air cool.

Technician(s)

Date

- 5.10 Remove the conductor from the brazing fixture and using a Brown Roloc (MA-274983) and a small buffer, remove any excess brazing material. Remove only material where the conductor exceeds the .4136" slot (maximum) of the Dekeystoning Gage (MB-351442). Refer to the Conductor Dekeystoning Procedure (5520-ES-318849).

Note(s):

Remove only the minimum amount of material necessary. At no time is the removal of material to produce an area in which the minimum gage .4056" (MB-351442) fits over the conductor.

Technician(s)

Date

- X-X** 5.11 Verify that the position of the brazed components are in accordance with ME-331982 and that there is no twists or damage in the conductor or brazed joint. Using the Conductor Dekeystoning Gage (MB-351442) ensure that the conductor is of the correct size at the brazed joint.

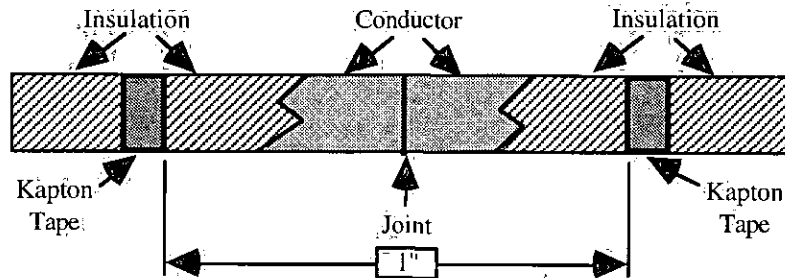
Crew Chief

Date

Inspector

Date

- 5.12 Reattach the Fiberglass Tape (MA-351462) using the (Coil Insulating Wrapper II ME-351226 or other pre-approved methods) with 1/2 lapped Fiberglass Tape (MA-351462). Prior to starting the winding operation, insulate over the braze joint and mark its location using Kapton Adhesive Backed Tape (MA-116534 or equivalent) as indicated in the diagram below. The insulation process is to be continued during the entire winding operation.



Note(s):

Transitions between the Fiberglass Tape (MA-351462) and the Fiber Glass Tape (MA-351462) must be made so that no area of the conductor is uninsulated and additional build-up of the tape is minimized.

Technician(s)

Date

6.0 Coil Winding (Top Layer)**Note(s):**

At this point the transition splice has been made, cooled, had any excess material removed and insulated with the joint marked.

At no time is a hammer to be used directly against the conductor.

X-X

- 6.1 Verify that all previous steps have been completed and that the joints as indicated by the Kapton tape are at least six (6") inches away from the radii of the coil and are not adjacent to each other.

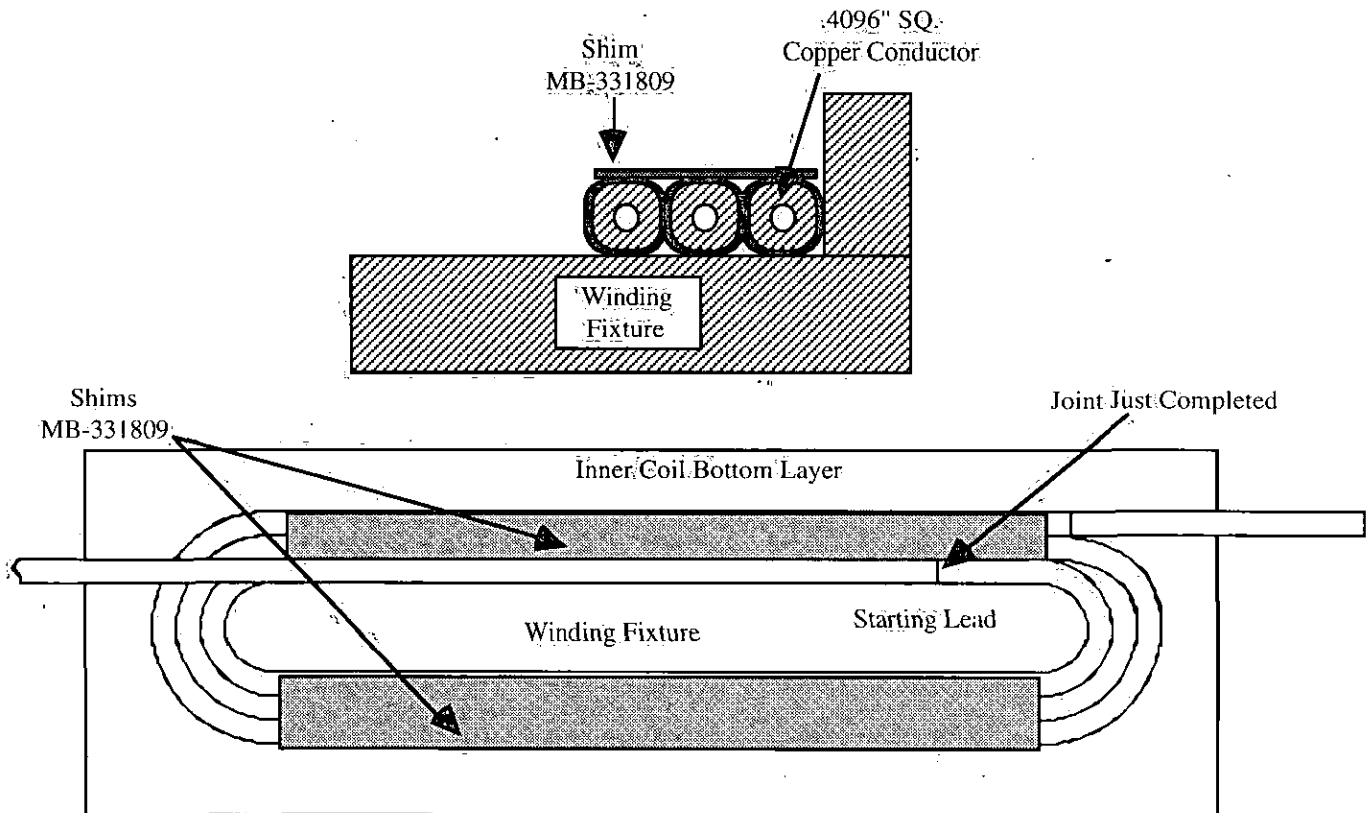
Crew Chief

Date

Inspector

Date

- 6.2 Position the two (2) shims (MB-331809) on top of the bottom coil layer along the straight sections and secure them in place.



Technician(s)

Date

- 6.3 Engage the winding table, continue insulating the conductor and use minimum hammer force necessary to form the turns and avoid conductor/insulation damage. Adjust the pressure valve to pressurize the tensioner clamping cylinder to 225 Lbs. \pm 25 Lbs. as winding continues ensuring that the maximum pressure does not exceed 250 Lbs force. Monitor the tension at all times. Continue winding through the second radius of the first turn until the insulated conductor contacts the long straight section of the winding fixture and stop. Clamp the conductor to the winding fixture using c-clamps.

Warning:

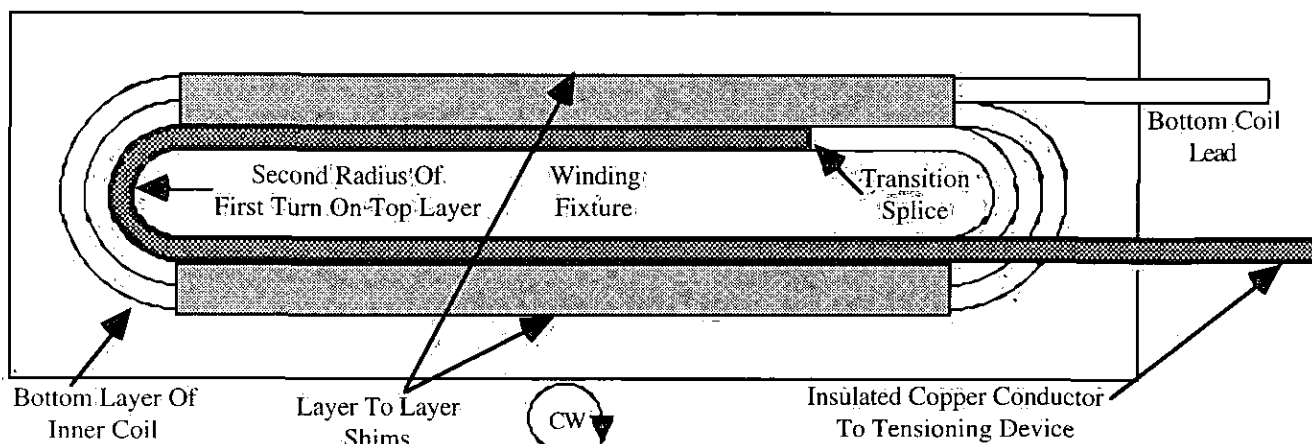
Continual visual inspection of the conductor is required during the winding process for voids in the insulation and or possible damage to the insulated conductor. At no time is a hammer to be used directly against the conductor.

If splicing is required refer to ME-331982 under Notes.

Note(s):

Fixture rotation should be clockwise.

The square conductor must be under constant tension and must not be allowed to twist during winding.



Technician(s)

Date

X

- 6.4 Perform a Height and Width Dimension Check of the uninsulated conductor half-way between the tensioner and the winding fixture.

Dimension	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Height	(.4056") to (.4136")				
Width	(.4056") to (.4136")				

Lead Person

Date

Note(s):

After completion of the first turn position DMD (MA-116514) between each turn at the radii.

- 6.5 Continue insulating and winding the coil in this manner until the two (2) turns of the second layer have been wound with the lead exiting the opposite side and parallel to the bottom layer lead, or until such time as additional conductor is required.

Warning:

Continuous monitoring of the conductor at the tensioner is required so as not to pull the conductor free of the tensioner. Ensure that during the winding process no twisting of the conductor occurs.

Note(s):

In the event additional conductor is required, allow at least four (4) feet of bare conductor to work with for facing and brazing operations.

Additional Conductor Required. Go to Step 6.6 ☐ See Caution.

Winding completed. Go to Step 6.26 ☐

Caution:

Per print ME-331982. There shall be a maximum of two (2) conductor joints per coil. Hence if additional conductor was added on the first layer, this step is not an option.

Technician(s)

Date

Note(s):

In the event no additional conductor is required step 6.6 through 6.23 will be blank.

- 6.6 Stop the winding/insulating process at the nearest radius that allows the conductor to remain in the tensioning device. Securely clamp the conductor to the winding fixture. Release the tensioner. Cut the lead as close to the tensioner as possible for machining, yet the cut and machined length must fall greater than six (6") inches from the nearest radius.

Note(s):

Do not insulate the conductor to the cut location. Leave four (4) feet uninsulated. Cutting the roll of Fiberglass tape and removal of the machine or leaving the machine and Fiberglass tape attach to the conductor is at the operators discretion.

Technician(s)

Date

Note(s):

In the event no additional conductor is required step 6.6 through 6.23 will be blank.

- 6.7 Install the coil starting lead into the Setco Counter Boring and Facing Fixture center the coil lead in the fixture, so there is $1/32" \pm 1/64"$ past the $5/16"$ Collet (SC Collar). Tighten the De-StaClamp to secure the coil starting lead into place.

Note(s):

Take care not to damage the conductor during the installation into the Counter Boring and Facing Fixture.

The drill bit must align with the center of the conductor not the center of the water passage.

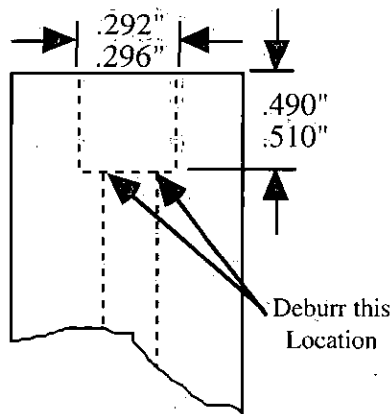
Technician(s)_____
Date

- 6.8 Machine and counter bore the coil lead as per ME-331982. Using a Tapered Ream (Fermi stock 1264-0800) or equivalent, deburr the water passage.

Note(s):

Use Snoop (Fermi stock 1070-2200 or equivalent) as required while machining the coil lead.

Do not remove any additional material from the face of the coil lead.



Deburr all sharp edges produced by the previous operations. Clean the conductor, water passages and the immediate area using a vacuum. Remove any additional milling chips from the water passages by holding the vacuum hose over one of the water passages and blowing air through the other water passage, switch the hoses and repeat until the water passage is free of debris.

Technician(s)_____
Date

Note(s):

In the event no additional conductor is required step 6.6 through 6.23 will be blank.

X

- 6.9 Verify the counter bore diameter and depth of the conductor using the Go/No Go Gage (MA-351136) or approved measuring equipment and that the conductor leads comply with ME-331982. Record the results in the table below:

Counter Bore Inspection						
Location	Limit	Pass	Fail	Limit	Pass	Fail
Coil Lead	.292"/.296"			.490"/.510"		

Lead Inspector

Date

- 6.10 Install a reel of grit blasted copper conductor (.4096" sq. MA-186587) on the tensioner spindle. Feed the conductor through the Phenolic guide block. Extend the conductor to the counter bore/facing machine.

Note(s):

Use the proper lifting equipment to prevent back injury during the installation of the reel on the tensioner spindle.
Ensure that no twist has occurred in the conductor between the reel and the Phenolic guide block.

Technician(s)

Date

- 6.11 Install the reel lead into the Setco Counter Boring and Facing Fixture center the coil lead in the fixture so there is 1/32" \pm 1/64" past the 5/16" Collet (5C Collar). Tighten the De-StaClamp to secure the coil starting lead into place.

Note(s):

Take care not to damage the conductor during the installation into the Counter Boring and Facing Fixture.

The drill bit must align with the center of the conductor not the center of the water passage.

Technician(s)

Date

Note(s):

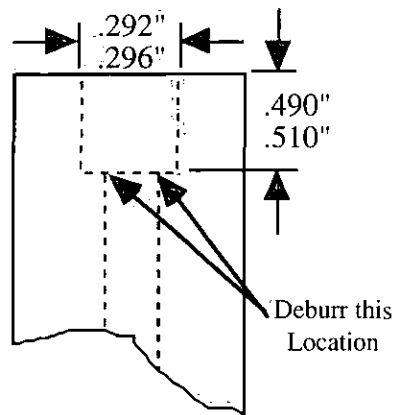
In the event no additional conductor is required step 6.6 through 6.23 will be blank.

- 6.12 Machine and counter bore the reel lead as per ME-331982. Using a Tapered Ream (Fermi stock 1264-0800) or equivalent, deburr the water passage.

Note(s):

Use Snoop (Fermi stock 1070-2200 or equivalent) as required while machining the coil lead.

Do not remove any additional material from the face of the coil lead.



Deburr all sharp edges produced by the previous operations. Clean the conductor, water passages and the immediate area using a vacuum. Remove any additional milling chips from the water passages by holding the vacuum hose over one of the water passages and blowing air through the other water passage, switch the hoses and repeat until the water passage is free of debris.

Technician(s)

Date

- X 6.13 Verify the counter bore diameter and depth of the conductor using the Go/No Go Gage (MA-351136) or approved measuring equipment and that the conductor leads comply with ME-331982. Record the results in the table below.

Counter Bore Inspection						
Location	Limit	Pass	Fail	Limit	Pass	Fail
Reel Lead	.292"/.296"			.490"/.510"		

Lead Inspector

Date

June 18, 1998

Rev. B

Note(s):

In the event no additional conductor is required step 6.6 through 6.23 will be blank.

- X 6.14 Assemble the Copper Sleeve (MA-186691) with the Sil-Fos #15 Washers (MA-351037), and the two (2) Sil-Fos #15 Rings (MA-186692) per print ME-331982.

Technician(s)_____
Date

- 6.15 Position the coil lead and the lead from the reel such that the two may be joined together. Assemble the sleeve into the lead of the coil and the lead of the reel.

Technician(s)_____
Date

- 6.16 Attach the brazing fixture (MB-351443) to the conductors about to be joined together. Align the conductors such that there is no twist between the two leads.

Technician(s)_____
Date

- X 6.17 Verify the position of the components to be brazed together as per ME-331982.

Lead Person_____
Date

- 6.18 Heat the leads with a torch until the area surrounding the joint is cherry red. Apply Sil-Fos # 15 (MA-116256) at the joint. Feed the Sil-Fos #15 into the joint and move the torch around the joint to produce 100% Sil-Fos #15 flow and a uniform braze. Refer to the General Brazing Specification (ES-318973).

Note(s):

CAUTION, material and areas being heated represent a burn hazard.

Do not over heat the material causing the copper to flow.

Do not use water to cool the joints. Allow all brazed joints to air cool.

Technician(s)_____
Date

- 6.19 Remove the conductor from the brazing fixture and cover the insulated coil/conductor with green Herculite (Fermi stock 1740-0100). Using Brown Roloc (MA-274983) and a small buffer, remove any excess brazing material. Remove only material where the conductor exceeds the .4136" slot (maximum) of the Dekeystoning Gage (MB-351442). Refer to the Conductor Dekeystoning Procedure (5520-ES-318849).

Note(s):

Remove only the minimum amount of material necessary. At no time is the removal of material to produce an area in which the minimum gage .4056" (MB-351442) fits over the conductor.

Technician(s)_____
Date

Note(s):

In the event no additional conductor is required step 6.6 through 6.23 will be blank.

XX

- 6.20 Verify that the position of the brazed components are in accordance with ME-331982 and that there is no twists or damage in the conductor or brazed joint. Using the Conductor Dekeystoning Gage (MB-351442) ensure that the conductor is of the correct size at the brazed joint.

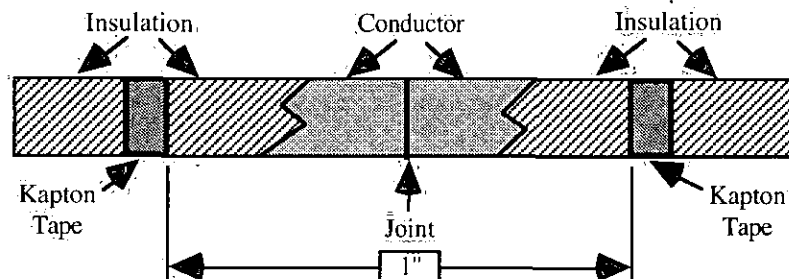
Crew Chief _____

Date _____

Inspector _____

Date _____

- 6.21 Reattach the Fiberglass Tape (MA-351462) using the (Coil Insulating Wrapper II ME-351226 or other pre-approved methods) with 1/2 lapped Fiberglass Tape (MA-351462) if required. Prior to starting the winding operation, insulate over the braze joint and mark its location using Kapton Adhesive Backed Tape (MA-116534 or equivalent) as indicated in the diagram below. The insulation process is to be continued during the entire winding operation.

**Note(s):**

Transitions between the Fiberglass Tape (MA-351462) and the Fiber Glass Tape (MA-351462) must be made so that no area of the conductor is uninsulated and additional build-up of the tape is minimized.

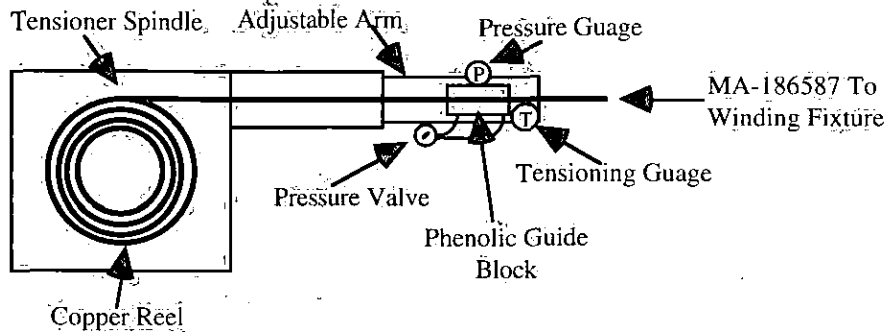
Technician(s) _____

Date _____

Note(s):

In the event no additional conductor is required step 6.6 through 6.23 will be blank.

- 6.22 Set the adjustable tensioning arm on the spindle to the half way point. Install a reel of copper conductor (.4096" sq. MA-186587) on the tensioner spindle and feed the conductor through the Phenolic guide block.

**Note(s):**

Use the proper lifting equipment to prevent back injury during the installation of the reel on the tensioner spindle.
Ensure that no twist has occurred in the conductor between the reel and the Phenolic guide block.

 Technician(s)

 Date

- 6.23 Begin winding table rotation (Clockwise) until the tensioner load cell gauge registers winding tension. Adjust the clamping cylinder pressure so that the load cell gauge reads 225 Lbs. force \pm 25 Lbs. Maximum pressure should not exceed 250 Lbs force.

 Technician(s)

 Date

X

- 6.24 Verify that the tension of the conductor load cell gauge reads 225 Lbs. force \pm 25 Lbs measured during the continued winding table rotation. Ensure that the maximum readings do not exceed 250 Lbs force. Visually verify that there is no exposed copper or damaged conductor wrap.

Record Actual Tension _____

 Pass ☐ Fail ☐

Conductor Wrap Is Free Of Damage And There Is No Exposed Copper

 Pass ☐ Fail ☐

 Lead Person

 Date

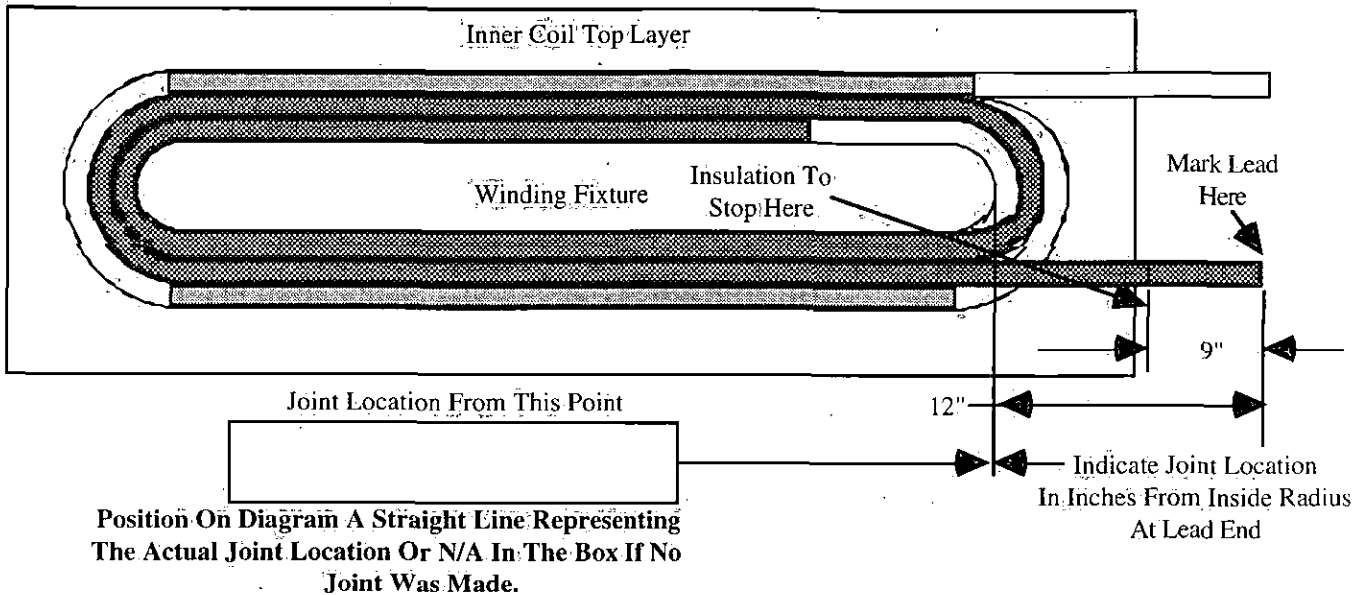
- 6.25 Continue insulating and winding the coil in this manner until the two (2) turns of the second layer have been wound with the lead exiting the opposite side and parallel to the bottom layer lead, then stop the winding process.

 Technician(s)

 Date

- 6.26 Clamp the conductor to the winding fixture. Measure $12" \pm 1/2"$ from the face of the Front End Winding Block (MC-331926) on the lead attached to the tensioning device and mark the lead to be cut. Secure the Fiberglass tape to the conductor 9" back from the 12" mark using Adhesive Backed Fiberglass Tape (MA-225104) or equivalent.

Caution: Do not cut lead.



In the diagram above, indicate the actual location of the joint just completed. N/A ☐

Technician(s)

Date

- XX 6.27 Verify that the two (2) turns are wound, that no twist is in the conductor, the lead is correctly measured and marked, that there is no damage to the insulation which is to include but not be limited to dirt, grease, oil, gaps/tears exposed conductor, etc... and that the shims are installed between the layers. Visually verify that after completion of the first turn DMD (MA-116514) has been positioned between each turn at the radii.

Lead Inspector

Date

Crew Chief

Date

- 6.28 Cut the lead as marked using a portable band saw or equivalent at the 12" mark. Deburr all sharp edges produced by the cutting. Clean the conductor, water passages and the immediate area using a vacuum. Remove any additional milling chips from the water passages by holding the vacuum hose over one of the water passages and blowing air through the other water passage, switch the hoses and repeat until the water passage is free of debris.

Technician(s)

Date

- 6.29 Stamp the coil serial number with 1/4" high letters per ME-331982/ES-331729.

Technician(s)

Date

- 6.30 Release the clamping devices holding the coil to the winding fixture. Carefully remove the coil assembly from the winding fixture.

Technician(s)

Date

- 6.31 Using Ty-Raps (Fermi stock 1150-2080 or equivalent) secure the coil sufficiently to ensure that no damage occurs to the insulated conductor during transportation.

Technician(s)

Date

- 6.32 Once the coil is in the wrapping room, separate the first turn which has no insulation on it in the radii. Apply DMD (MA-116514) on the conductor next to the second turn at the radii. Insulate over the DMD with 1/2 lapped Fiberglass Tape (1/2" wide MA-351462 or 1" wide MA-116511).

Technician(s)

Date

XX

- 6.33 Visually inspect the coil for damaged insulation, exposed copper, proper placement of shims etc...

Crew Chief

Date

Lead Inspector

Date

- 6.34 Stage the coil in the inspection area.

Technician(s)

Date

7.0 Final Inspection

- X 7.1 Perform a Post Conductor Wrap Electrical inspection and record the results below.

Electrical Test	Equipment Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Resistance		3.3 mΩ to 3.7 mΩ				
LS @ 1 KHz		Reference Test Only Not Subject to Limit Values				
Q @ 1 KHz		Reference Test Only Not Subject to Limit Values				
LS @ 100 Hz		33 μH to 41 μH				
Q @ 100 Hz		5.0 to 6.0				
100 Volt Ring		Reference Test Only Not Subject to Limit Values				

Inspector _____

Date _____

- X 7.2 Visually verify the following.

Conductor Wrap Is Free Of Damage And There Is No Exposed Copper. Pass ☐ Fail ☐Verify the DMD is installed between the turns of the coil at the radii. Pass ☐ Fail ☐

Inspector _____

Date _____

- X 7.3 Perform a Flow Check at a ΔP of 60 PSI and 100 PSI. A hydrostatic check at 500 PSI and record the results below. Refer to the 3Q60/3Q120 Quadrupole Test Specifications (ES-331810).

Flow Cart Serial Number		
Number of Joints (2 Maximum)		
Desired ΔP	Minimum Flow in GPM	Attained Flow in GPM
60 PSI	1.10 GPM	
100 PSI	1.45 GPM	

Perform a hydrostatic check of the joints at 500 PSI for 30 minutes. Pass ☐

Inspector _____

Date _____

XX 7.4 Verify that the previous steps are within tolerance.

Lead Inspector

Date

Crew Chief

Date

7.5 Stage the coil in the coil staging area.

Note(s):

**Cover 3Q60 Coil Assembly with green Herculite
(Fermi stock 1740-0100).**

Technician(s)

Date

8.0 Production Complete

XXX

- 8.1 Process Engineering verify that the FMI 3Q60 Outer Coil Winding Traveler (5520-TR-333290) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

Process Engineering/Designee

Date

XXX

- 8.2 Assembly verify that the FMI 3Q60 Outer Coil Winding Traveler (5520-TR-333290) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

Assembly/Designee

Date

- 9.0 Attach the Process Engineering "OK to Proceed" Tag on the coil.

Process Engineering/Designee

Date

- 10.0 Proceed to the next major assembly operation - 3Q60 Coil Assembly/Insulation Traveler (5520-TR-333291).